

## **Teacher Resource Kit**

This kit is designed as a resource for teachers who teach grades K-5. It is intended to provide information about the Laboratory and our education resources and to introduce activities that may be useful in the classroom.

The kit contains information about the Laboratory's history and current research activities. You will find information applicable to various grade levels that can be tailored to the grade level that you currently teach.

Also included are materials and activities that have been obtained from sources outside the Laboratory.



# Requesting support from Los Alamos National Laboratory

The Laboratory and its employees consider it their responsibility to devote resources to improving the quality of life in our community and believe that when people work together, great things happen. We work with many partners, including our local schools and non-profit organizations. We work not only through our Science Education Community Service Time program but also through employee volunteerism. Below, you will learn more about both of these efforts and how the Laboratory can help support the community. You will also learn how you can request assistance from Laboratory employees for help in your classroom.

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The Laboratory encourages its employees and retirees to get involved by giving their time, and talent to education initiatives and community efforts. The goal is to match employee interests with regional educational and community needs by actively recruiting, retaining, recognizing, and rewarding their service. There are two ways in which employees provide service:

**1. Science Education Community Service Time**

Employees are allowed to use up to 32 hours of paid time (with management approval) to support Science, Technology, Engineering or Math Initiatives (STEM). This includes supporting activities such as judging science fairs, mentoring, tutoring, etc.

**2. Database for Requesting Support from Laboratory employees**

To request support for STEM-related activities/initiatives, visit the Laboratory's website at:

[http://www.lanl.gov/orgs/cpo/education\\_programs/STEM/stem\\_form.shtml](http://www.lanl.gov/orgs/cpo/education_programs/STEM/stem_form.shtml)

Please allow up to two weeks for us to match your request with a Laboratory employee. We will make every effort to fill all requests.

- 3. Vecinos Volunteer Program** – Employees and retirees volunteer their personal time for various activities, and Los Alamos National Security, LLC, the company that manages the Laboratory for DOE, rewards our Vecinos Volunteers annually by making monetary rewards on their behalf (up to \$250,000) to nonprofit organizations where our volunteers serve. Employees record their hours served on Volunteermatch.org, an online resource where volunteers record their hours and locate volunteer opportunities. Retirees also record their hours through the Retired Senior Volunteer Program (RSVP) at the Betty Ehart Center in Los Alamos.



# Career Interest Exercise

(All grades)

While it is not common for students in grades K– 5 to know exactly what types of careers they will pursue as adults, it may be beneficial to start talking about these opportunities so they understand the options that are available they can begin thinking about how to pursue their interests. You may ask students if their parents work at the Laboratory and if they know what they do in their jobs.

**Classroom Activity:** The list below is a sample of job descriptions at the Laboratory. Share this list with your students and have a classroom discussion on the various opportunities that exist, and ask each student which of these jobs appeal most to them. Have them share their thoughts on what they think they need to learn in order to have one of these jobs. For example, a student who wants to be an accountant should be comfortable doing math and working with numbers. A graphic artist could be a visually creative person. Students may also want to identify their peers qualities and suggest what they may be good at.

**Accountant** – Prepares, examines, and analyzes accounting records and financial statements.

**Architect** – Researches, plans, designs, and administers the planning and design of building projects.

**Attorney** – Provides legal advice, counsel, and representation to Laboratory management and employees.

**Auditor** – Plans, schedules, and conducts internal audits and provides investigation support addressing Laboratory's efficiency and effectiveness of operations.

**Chemical Engineer** – Deals with the technology of large-scale chemical production and the manufacture of products through a chemical process.

**Development and Fabrication Tec** – Assembles, tests, and modifies distinctive/prototypical electrical and/or mechanical components.

**Counterintelligence Analyst** – Assists in conducting counterintelligence analysis to assess potential threats posed by intelligence collection activities of foreign powers or entities and international terrorist activities

**Explosives Tec** – Provides technical and operational support associated with various types of experiments that use high explosives and other energetic materials.

**Geographic Information Systems (GIS) Specialist** – Provides geographic information in support of Laboratory planning and/or environmental activities.

**Graphic Artist** – Plans, develops, and produces a variety of two-dimensional and three-dimensional graphic products for scientific and administrative publications, exhibits, and multimedia displays.

**Library Professional** – Supports Laboratory researchers by using, providing access to, and enhancing the use of information.



## Career Interest Exercise (cont'd)

**Machinist** – Sets up and operates basic machining tools to fabricate metal parts, mechanisms, tools, or machines to exact dimensions

**Media Productions/Services Specialist (includes Photographers)** – Researches, prepares, and produces digital imagery (still or video) for training, promotion, documentation, or other Laboratory purposes for internal and external audiences.

**Nurse** – Applies nursing principles and provides direct nursing care to patients.

**Packing Specialist** – Ensures safe and compliant packaging and transportation of any and all classes of nuclear material; explosives, other Hazardous materials; and/or classified matter.

**Radiation Control Technician** – Provides routine radiation monitoring and survey support.

**Training Specialist** – Provides technical and non-technical training and education programs services to the Laboratory.

**Web Administrator/Developer** – Develops and maintains Laboratory websites.

**Writer/Editor** – Plans, writes, and edits technical and administrative documents and products such as brochures, web pages, and reports.



# Los Alamos

## Employees' Scholarship Fund (LAESF)

The Laboratory and its employees know that one of the most important investments in our community is to invest in the future of our children. Since 1998, scholarships have been awarded to students in Northern New Mexico who are pursuing four-year degrees in fields that will serve the region. Awards are based on academic performance, leadership potential, critical thinking skills, and career goals. In 2013, a total of 73 scholarships were awarded to students in Northern New Mexico through LAESF. Below are number of scholarship recipients by county.

### 2013 LAESF Scholarships Recipients by County

Los Alamos	17
Mora	2
Rio Arriba	16
San Miguel	8
Sandoval	3
Santa Fe	18
Taos	9

**Classroom Activity:** Introduce the term “scholarships” and “college” to your students so that they get an understanding of the importance of doing their best in school and having the opportunity to someday apply for a scholarship, especially since the cost of going to college is rising.



**Rebecca Martinez** was a recipient of a LAESF scholarship. Here are a few of her accomplishments:

- Employed as technical project manager at the Laboratory, she currently manages a multi-million dollar construction project at the Laboratory's plutonium facility
- Attended the University of New Mexico and received an undergraduate degree in engineering
- Honored as the engineering student of the year for 2007-08 by the NM Society of Professional Engineers
- Honored as one of three valedictorians at Espanola Valley High School



# Energy Conservation and Environmental Sustainability

We all know that recycling is extremely important to the environment. At the Laboratory employees are encouraged to recycle whenever possible. In fact, last year the Laboratory recycled 47% of its solid, non-hazardous waste, which equates to almost 1,275 metric tons of paper, cardboard, plastic bottles, and soda cans. The Laboratory was also able to recycle 93% of its construction and demolition waste (nearly 7,000 tons of debris and scrap materials), and reused more than 5,000 of the 20,188 cubic yards of clean soil from construction and demolition activities onsite.

**Classroom Activity:** Using the facts below, you may want to share this information with your class by asking the students if they can guess the answers. The objective is to remind students about the importance of recycling.

- How much water can you save if you turn off the faucet while brushing your teeth? Answer: Up to eight gallons of water per day. This is a savings of 240 gallons of water per month.
- How many gallons of water would this save each year if you shower instead of taking a bath?  
**Answer:** A full bath tub uses 70 gallons of water, but taking a five-minute shower only uses 10-25 gallons of water.

## Other interesting facts:

- The Sanitary Effluent Recycling Facility (SERF) at LANL can recycle up to 300,000 gallons of water each day. That's enough water to fill an Olympic-size swimming pool three times each week!

## Electricity

Electricity can be generated from several sources, including the sun, running water, or wind. Electricity is most often generated by burning coal. Saving electricity by turning off lights and appliances after each use is important and can help save resources.

In 2012, one team at the Laboratory switched its project from using two large computer servers to using dozens of smaller computer servers. That change alone helped save 735,000 kilowatt-hours each year.

- How many kilowatt-hours per year does the average American household use? Answer: 12,000 kilowatt-hours per year.

## Recycling Materials

Where possible, many materials can be recycled, such as metal, paper, and concrete. Recycling these materials saves resources and space in landfills.

Paper is made from the wood pulp of trees, and paper is one of the most commonly recycled products. Employees at the Laboratory help recycle more than 20 tons of paper on average each month!

Recycling one ton of paper saves 17 mature trees, 7000 gallons of water, three cubic yards of landfill space, two barrels of oil, and 4000 kilowatt hours of electricity.

- How many recycled aluminum cans do you think it would take to save enough energy to run a 100-watt light bulb for 20 hours, a computer for three hours, and a television for two hours? Answer: One

The Laboratory recycles more than 50 tons of steel and aluminum each month.



## Meet Our Director



### Director, Charles (Charlie) F. McMillan

Being the Director of the Laboratory is a very important job. One of the qualifications for a Director is to be a nationally recognized science leader with a great deal of experience in leading-edge scientific research and management. One of Charles McMillan's responsibilities includes overseeing about a \$2.2 billion dollar budget each year from the Department of Energy (DOE) and other governmental agencies. He also is responsible for ensuring the safe and productive oversight of the Laboratory's multiple missions. He has to have knowledge of the nation's fast changing research environment so that the Laboratory can adjust accordingly. This also means that he has to be in constant contact with our national and local leaders.

Dr. McMillan was appointed the 10<sup>th</sup> Director of the Laboratory on June 1, 2011. He led the Laboratory's weapons physics organization from 2006 to 2011. Before coming to Los Alamos, he served in a variety of research and management positions at Lawrence Livermore National Laboratory in California.

#### Facts about Charles McMillan:

- Holds a doctorate in physics from the Massachusetts Institute of Technology
- Holds bachelor's degrees in mathematics and physics from Columbia Union College
- Has been awarded two DOE Awards of Excellence
- Is an avid photographer and accomplished musician who plays piano, organ, and recorder

**Classroom Activity:** You may ask your students if they have a particular question that they would like to ask the Director. Students are welcome to send their questions to the following address. Responses from the Director will be based on the number of letters received.

Los Alamos National Laboratory  
Attn: Director, Charles McMillan  
c/o Fred deSousa  
PO Box 1663, MS A100  
Los Alamos, NM 87545

(A template for writing the letter is available on the reverse side of this sheet)



Dear Director McMillan,

My name is \_\_\_\_\_ and I attend school at \_\_\_\_\_. I am in \_\_\_\_\_ grade.

I would like to ask you the following question (s):

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My return address is the following:

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Sincerely,

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## NOTABLE SCIENTISTS

The Laboratory is known as the nation's premier national science laboratory. Our mission requires a multidisciplinary scientific approach for solving some of the nation's toughest challenges, including ensuring the safety, security, and reliability of the U.S. nuclear deterrent; reducing global threats; and energy security. Below are some highlights about some of the notable scientists who have made outstanding contributions in those areas.

**Classroom Activity:** Ask your students to research the following notable and current scientists and match the names with the photos below. On the back of this sheet, students can also match the names of current scientists to their photos.

1. **Frederick Reines** discovered the neutrino with Clyde Cowan in 1956, for which he won the Nobel Prize (1995). Thus, Los Alamos has played a role in a long line of particle physics discoveries which continue to this day, most recently with the Higgs Boson.
2. **George Grover** invented heat pipes at Los Alamos in 1963. Despite their name, they are used to “cool” devices by redirecting the heat they produce. Heat pipes are used in machines as large as NASA satellites and as small as your personal laptop.
3. After working on the Manhattan Project, **Louis Rosen** worked at the Lab for the rest of his career and founded the Los Alamos Neutron Science Center (LANSCE), one of the world's most powerful linear accelerators.
4. While at Los Alamos, **Walter Goad** helped found GenBank, a freely available collection of nucleotide sequences from all sorts of organisms, promoting biological research throughout the world.



## CURRENT SCIENTISTS

1. **Sara Del Valle** works with her team to develop mathematical and computer models to study diseases such as smallpox, malaria, AIDS and influenza.
2. **Park Williams** is exploring how future climate change may change forests in the Southwest and elsewhere.
3. **Roger Wiens** is part of a team that invented ChemCam science experiment aboard the rover Curiosity. ChemCam uses a laser to blast pieces of Martian rock in search of elements like carbon and oxygen.
4. **Karissa Sanbonmatsu** is unraveling a secret that tells how DNA is reprogrammed during life.

As on the previous page, you can have your students match names to the faces of these scientists. They can research by visiting: <http://www.lanl.gov/index.php>



# Presidents of the United States of America Who Have Visited Los Alamos National Laboratory

**Classroom Activity:** You may share the following information as part of a history lesson to let your students know about the Laboratory's significant national role.

**John F. Kennedy** – visited Los Alamos on December 7, 1962, to learn about nuclear-powered engines for space exploration “You here in this mountain town make a direct contribution not only to the freedom of this country, but to those thousands of miles away...I am proud, as President of the United States, to come here today and express our thanks to you.”

**Lyndon Johnson** – Johnson accompanied Kennedy while serving as his Vice President.



**Gerald Ford** – as Vice President to Richard Nixon, Ford visited Los Alamos on July 12, 1974, for briefings and to learn about controlled thermonuclear research “I want to express my satisfaction to you and all the members of your staff at Los Alamos Scientific Laboratories for a most profitable and enjoyable visit.”



**Ronald Reagan** – visited in 1967 while serving as Governor of California and as a Regent of the University of California.



**Bill Clinton** – visited twice: Once in 1993, at the request of New Mexico Senator Jeff Bingaman, and again in 1998. At the Laboratory he took a tour of supercomputers, voiced support for stockpile stewardship, and addressed Lab employees: “Can you affect the future of America as you have the past? I think the answer is a resounding yes.”

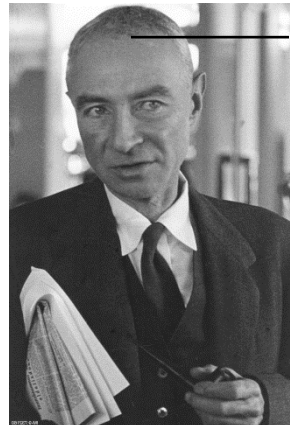
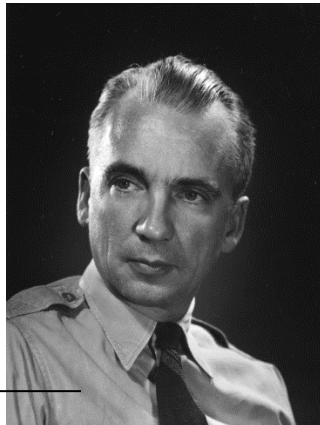




## Wartime Figures (World War II)

**Classroom Activity:** Ask your students to research the following World War II figures, and match their names with the photos below.

1. **General Leslie Groves** was the military leader of the nationwide Manhattan Project that resulted in the first atomic bombs. He also led the construction of the Pentagon building in Washington D.C.
2. **J. Robert Oppenheimer** was the first scientific leader of Los Alamos Laboratory, during the Manhattan Project. He later headed Princeton's Institute for Advanced Study, which included scientists such as Albert Einstein.
3. Before joining the Manhattan Project, **Enrico Fermi** built the world's first nuclear reactor, and had already won a Nobel Prize in part for his discovery of new elements. At Los Alamos he served as a division leader and one of Oppenheimer's Associate Directors.
4. **Hans Bethe** headed the Laboratory's Theoretical Division, which solved problems like calculating the critical mass of uranium. In 1967, he won a Nobel Prize for work on the theory of nuclear reactions...in stars.
5. **Captain William "Deak" Parsons**, raised in New Mexico, was an Associate Director at Los Alamos, responsible for the delivery of the atomic bombs. He armed the Little Boy atomic bomb that was dropped on Hiroshima.
6. **Norris Bradbury** assembled the non-nuclear components of the "Gadget" for the Trinity test, and then stayed on at Los Alamos to become Laboratory Director, a position he held for 25 years, allowing the Laboratory's scientific research to continue and expand.



# LANL 70TH ANNIVERSARY MATH (Kindergarten)

The Laboratory's Math and Science Academy provides high-quality STEM professional development for teachers in participating schools and districts. It is an intensive three-year program, designed to support whole-school continuous improvement in math and science teaching and learning. The problems below were designed by one of the Academy's master teachers.

1. Joe has four toy cars. Doris has three toy cars. How many cars do they have altogether?
2. There are two more pears than oranges. If there are six pears, how many oranges are there?

## ONLINE RESOURCES

- WOLFRAMALPHA: COMPUTATIONAL KNOWLEDGE ENGINE
  - <http://www.wolframalpha.com>
  - <http://blog.wolframalpha.com/2013/01/15/math-for-all-ages-online-manipulatives-for-basic-arithmetic/>
- NATIONAL LIBRARY OF VIRTUAL MANIPULATIVE  
<http://nlvm.usu.edu/en/nav/vlibrary.html>
- IXL: ONLINE MATH LESSONS AND PRACTICE  
<http://www.ixl.com>

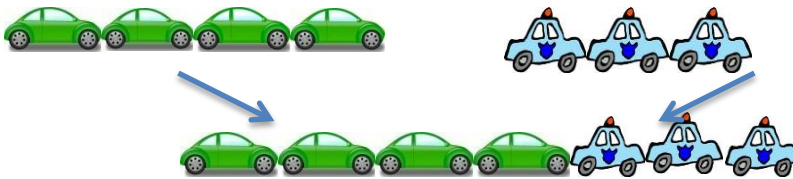


# LANL 70TH ANNIVERSARY MATH

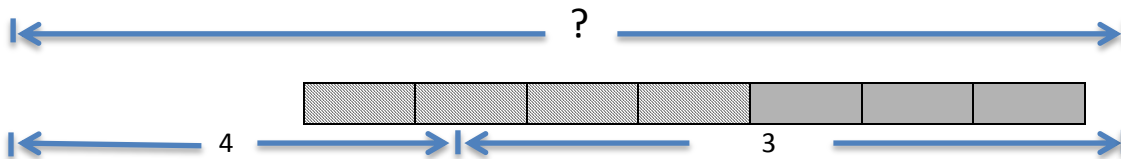
## (Kindergarten)

### Solutions

1. Joe has four toy cars. Doris has three toy cars. How many cars do they have altogether? Use concrete objects or a picture at the beginning of the year, then use a bar model early in the first semester to represent the group brought together, like so:



Bar Model



2. There are two more pears than oranges. If there are six pears, how many oranges are there?

				← Difference →	

# LANL 70TH ANNIVERSARY MATH

## (1<sup>st</sup> and 2<sup>nd</sup> grade)

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The Laboratory's Math and Science Academy provides high quality STEM professional development for teachers in participating schools and districts. It is an intensive three-year program, designed to support whole-school continuous improvement in math and science teaching and learning. The problems below were designed by one of the Academy's master teachers.

1. Find the difference between these two numbers: 70 and 7. Explain the difference between the two numbers? (Hint: Use a number line or bars to help you calculate and think).

$$70 - 7 = \square$$

- a. Here is another problem,  $17 - 8$ . Explain what happens to the difference if I increase both the first number and second number by 3, like so:

$$17 - 8 = \square$$

$$17 - 8 \rightarrow 20 - 11 =$$

- b. Here is the same problem with a twist,  $17 - 8$ . Explain what happens to the difference if I decrease the second number (8) by 3 and keep the first number the same, like so:

$$17 - 8 = \square$$

$$17 - 8 \rightarrow 17 - 5 = \square$$

- c. Explain what happens to the difference if I increase the second number (8) by 2 and keep the first number the same, like so:

$$17 - 8 = \rightarrow 17 - 10 = \square$$

### ONLINE RESOURCES

- WOLFRAMALPHA: COMPUTATIONAL KNOWLEDGE ENGINE
  - <http://www.wolframalpha.com>
  - <http://blog.wolframalpha.com/2013/01/15/math-for-all-ages-online-manipulatives-for-basic-arithmetic/>
- NATIONAL LIBRARY OF VIRTUAL MANIPULATIVE  
<http://nlvm.usu.edu/en/nav/vlibrary.html>
- IXL: ONLINE MATH LESSONS AND PRACTICE  
<http://www.ixl.com>





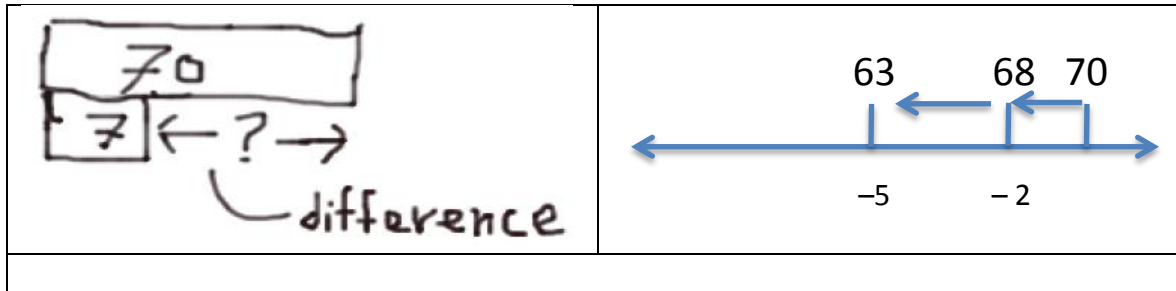
# LANL 70TH ANNIVERSARY MATH

## (1<sup>st</sup> and 2<sup>nd</sup> grade)

### Solutions

1. Find the difference between these two numbers: 70 and 7. Explain the difference between the two numbers.  
(Hint: Use a number line or bars to help you calculate and think).

$$70 - 7 = \square$$



- a. Here is another problem,  $17 - 8$ . Explain what happens to the difference if I increase both the first number and second number by 3, like so:

$$17 - 8 = \square$$

$$17 - 8 \rightarrow 20 - 11 = 9$$

Using an alternative subtraction strategy, adding an equal quantity to both the minuend and the subtrahend to turn the minuend into a benchmark number, like so,  $17 - 8 \rightarrow 20 - 11$ , the subtraction can then more easily be calculated mentally because the addition of three points to 17 and 8 is a 3 point slide from 8 to 11 and 17 to 20, respectively, so,  $17 - 8 = 9$  and  $20 - 11 = 9$ .

$$8 \rightarrow 11 \quad 17 \rightarrow 20$$



- b. Here is the same problem with a twist,  $17 - 8$ . Explain what happens to the difference if I decrease the second number (8) by 3 and keep the first number the same, like so:

$$17 - 8 = \square$$

$$17 - 8 \rightarrow 17 - 5 = \square$$

- c. Explain what happens to the difference if I increase the second number (8) by 2 and keep the first number the same, like so:

$$17 - 8 \rightarrow 17 - 10 = \square$$

# LANL 70TH ANNIVERSARY MATH

## (1<sup>st</sup> and 2<sup>nd</sup> grade)

### Solutions (cont'd)

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Increasing the subtrahend by 2, and changing the 8 to the benchmark number 10, decreases the distance between 17 and 8 by 2 units. So, I have to add 2 units to the difference between 17 and 10 to get back to the original distance between 17 and 8, like so,  $17 - 8 = \rightarrow 17 - 10 = 7 \quad 7 + 2 = 9$

Again, using an alternative subtraction strategy, that is decreasing the subtrahend by a quantity of 3 to change the 8 into the benchmark number, 5, increases the distance between the minuend and subtrahend. So, instead of the distance being 9 steps from 17 to 8, the distance is now 12 steps, 17 to 5. In effect, I took 3 more away than I needed to, making the difference larger by 3, now, I have to subtract 3 from the new difference.

$$17 - 8 \rightarrow 17 - 5 = 12, \text{ so,} \\ 12 - 3 = 9.$$

Explain what happens to the difference if I increase the second number (8) by 2 and keep the first number the same, like so:

$$17 - 8 = \rightarrow 17 - 10 = \square$$

Increasing the subtrahend by 2, and changing the 8 to the benchmark number 10, decreases the distance between 17 and 8 by 2 units. So, I have to add 2 units to the difference between 17 and 10 to get back to the original distance between 17 and 8, like so,

$$17 - 8 = \rightarrow 17 - 10 = 7 \\ 7 + 2 = 9$$

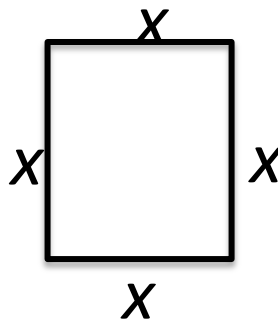
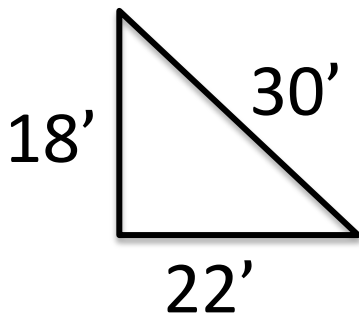


# LANL 70TH ANNIVERSARY MATH

## (4<sup>th</sup> and 5<sup>th</sup> grade)

The Laboratory's Math and Science Academy Program provides high quality STEM professional development for teachers in participating schools and districts. It is an intensive three-year program, designed to support whole-school continuous improvement in math and science teaching and learning. The problems below were designed by one of the programs master teachers.

1. What is the main idea behind the **Fundamental Theorem of Arithmetic (FTA)**, and why is the FTA an important idea in understanding numbers, gaining numbers sense, and in educating our mathematics intuition?
2. What are the factors of 70?
3. Find the prime factors of 70.
4.  $14 \times 5 = 70$  and  $\frac{28}{2} \times \frac{10}{2}$  also equals 70. Explain why. I want to see your mathematical thinking, so use images (e.g., models, tables, graphs, or pictures) numbers, and words to communicate your thinking.
5. If both the square and the triangle below have the same perimeter, what is the length of each side of the square? Explain your mathematical thinking using numbers, pictures, and words. Show your mathematical thinking, use images (e.g., models, tables, graphs, or pictures) numbers, and words to illustrate your thinking.



### ONLINE RESOURCES

- WOLFRAMALPHA: COMPUTATIONAL KNOWLEDGE ENGINE
  - <http://www.wolframalpha.com>
  - <http://blog.wolframalpha.com/2013/01/15/math-for-all-ages-online-manipulatives-for-basic-arithmetic/>
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- IXL: ONLINE MATH LESSONS AND PRACTICE <http://www.ixl.com>



# LANL 70TH ANNIVERSARY MATH

## (4<sup>th</sup> and 5<sup>th</sup> grade)

### Solutions

1. What is the main idea behind the **Fundamental Theorem of Arithmetic (FTA)**, and why is the FTA an important idea in understanding numbers, gaining numbers sense, and in educating our mathematics intuition?

“Every positive integer, except 1, is a [unique] product of primes.”

(Hardy & Wright, 1979, p.2).

2. What are the factors of 70?

**Factors of 70 are:**

**1 | 2 | 5 | 7 | 10 | 14 | 35 | 70 |**

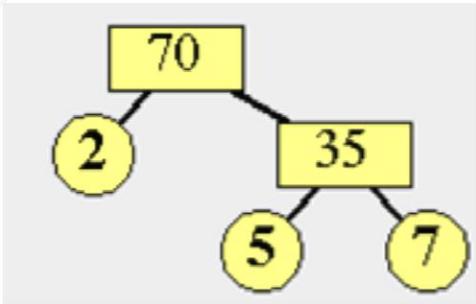
$$1 \times 70 = 70$$

$$2 \times 35 = 70$$

$$5 \times 14 = 70$$

$$7 \times 10 = 70$$

3. Find the prime factors of 70.

Factor Tree Algorithm	L—Algorithm	
	<u>2</u>	70
	<u>5</u>	35
		<u>7</u>

- Prime Factors are **2 x 5 x 7**



# LANL 70TH ANNIVERSARY MATH (4<sup>th</sup> and 5<sup>th</sup> grade)

## Solutions (cont'd)

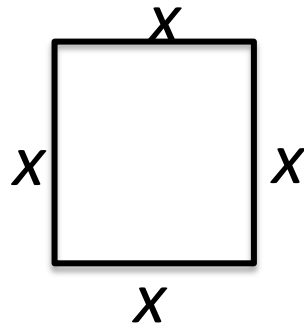
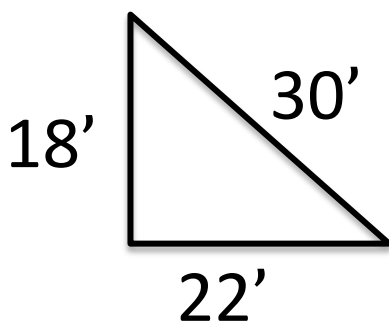
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4.  $14 \times 5 = 70$  and  $\frac{28}{2} \times \frac{10}{2}$  also equals 70. Explain why. I want to see your mathematical thinking, so use images (e.g., models, tables, graphs, or pictures) numbers, and words to communicate your thinking.

$\frac{70}{4} = 17.50$  is the rational expression of 14 and 5, respectively, that is,  $28 \div 2 = 14$  and  $10 \div 2 = 5$ , thus  $\frac{28}{2}$  and  $\frac{10}{2}$  is 70.

Another way to see  $\frac{28}{2}$  and  $\frac{10}{2}$  is communicate  $\frac{28}{2} \times \frac{10}{2}$  is  $\frac{10}{2}$  of  $\frac{28}{2}$  is  $\frac{140}{2}$  or 70 or 10 halves of 28 halves is 140 halves or 70, can be interpreted as 5 groups of 14 is 70 or  $\frac{140}{2}$ . It is important to see fractions notation as both a fraction and as an integer divided by an integer.

5. If both the square and the triangle below have the same perimeter, what is the length of each side of the square? Explain your mathematical thinking using numbers, pictures, and words. I want to see your mathematical thinking, so use images (e.g., models, tables, graphs, or pictures) numbers, and words to illustrate your thinking.



The perimeter of a triangle has three sides, which may be equal or unequal, but a square, by definition, has four equal sides. So, by adding the sides of the triangle  $18' + 22' + 30' = 70'$  and, then, finding the length of one side of the square  $\frac{70}{4} = 17.50'$ , I determine that each side of the square is 17.50'.



# Planetary Math

Galileo described mathematics as the language of science. At the Laboratory, people do math all the time. We deal with enormous numbers, as well as tiny numbers, in many different fields. Sometimes we need extreme precision, and at other times it is important to recognize that the best we can do, or all we really need to do, is estimate. It is also important to recognize that numbers can be used to represent the activities of actual physical systems. The ability to calculate and estimate numbers are critical. Astronomy often requires us to work with fabulously large numbers, but here we have tried to use examples with concepts and numbers on a scale that students can relate to.

The Laboratory has conducted space science since the dawn of the space age. We operate instruments on satellites, we watch the sun and other stars closely, and we have components on the Mars Science Laboratory rover, Curiosity. We are powering spacecraft such as Cassini, to study Saturn; New Horizons, on its way to take the first close look at Pluto, and Voyager 1, which is currently hurtling through the edge of the solar system into interstellar space, and still “phoning home.”

## Classroom Activities:

A year on any planet is the length of time it takes to orbit one time around its star. An eight-year-old on Earth has been all the way around the sun eight times. That is a journey of almost 600 million miles. Mercury orbits the sun every 88 Earth days, or four times every Earth year. Neptune takes 165 Earth years to orbit the sun.

1. How old would you be if you lived on Mercury?
2. How old would you be if you lived on Neptune?
3. How old would your great-grandmother be if she lived on Neptune?
4. If Anna is four and Michael is two, is Anna twice as old as Michael?
5. What if Anna’s birthday was last week, and Michael’s is next week? (Draw a number line.)

The Earth takes  $365 \frac{1}{4}$  days to orbit the sun. The moon orbits Earth every 27.3 days, travelling eastward. The rotation and revolution of the Earth and the moon are all in the same direction, counter-clockwise if viewed from the North Star. It takes  $29 \frac{1}{2}$  days for the moon to complete its cycle from full moon to full moon.

6. If the moon orbits toward the east, why does it rise in the east and set in the west?\*
7. Why is the moon’s orbit two days shorter than its phase cycle?\*\*\*

The Kepler space telescope is aimed along our limb of the spiral Milky Way galaxy. Its field of view includes about 100,000 stars that are somewhat close to us. It is trying to detect the shadows of planets that pass between us and the stars and the wobble of the stars as they are pulled by their planets’ gravity. One thing Kepler has established is that nearly all the stars in our galaxy, that have been studied closely, have planets. It is possible that  $1/6^{\text{th}}$  of them have a planet like Earth in size, distance and temperature.

8. If there are one billion stars in our galaxy, what fraction of them are among Kepler’s 100,000?
9. If only  $1/10^{\text{th}}$  of all the stars in our galaxy have Earthlike planets, how many such planets would there be in the Milky Way?
10. If life evolved on only one earthlike planet in 1,000, how many planets in the Milky Way would harbor life?  
If life was one in a million?



*(continued on next page)*

\*The moon rises and sets east to west because Earth rotates toward the east much faster than the moon orbits. The moon rises or sets just a little later every day because its actual eastward motion is subtracted from this apparent westward motion.

\*\*The moon's orbit is timed relative to very distant stars. Its phases are caused by the local geometry of the sun, Earth, and the moon. In 27 days, Earth moves almost 1/12 of the way around the sun, which affects the way light falls across the face of the moon from our perspective.

## Planetary Math Answers

1. Multiply the person's age times 4.
2. We would never ever be 1 on Neptune.
3. And neither would our great-grandmother. We'd all be the same age in years.
4. It depends. . . the way we use ages has interesting ramifications. (see #5)
5. Anna is just barely four and Michael is nearly three, so she is not twice as old as he is. On the other hand, if Anna's birthday was next week, and Michael's was last week, then she'd be nearly five and he'd be just two.
6. Earth's rotation is much faster than Moon's orbit, so the illusion of rising and setting overwhelms the actual motion of the moon.
7. Please refer to the footnote. Draw a picture of a clock face, earth moves about one hour every month.
8.  $100,000 / 1,000,000,000 = 0.0001$  or one ten-thousandth of the stars in our galaxy.
9. One hundred million. This might be a conservative guess for the number of Earthlike planets in our galaxy. (What are the odds for intelligence? The jury is still out.)
10. 100,000 or one hundred thousand planets. If life were a one in 1,000,000 shot, there would still be 100 planets in our galaxy alone. (There are billions and billions of galaxies.)

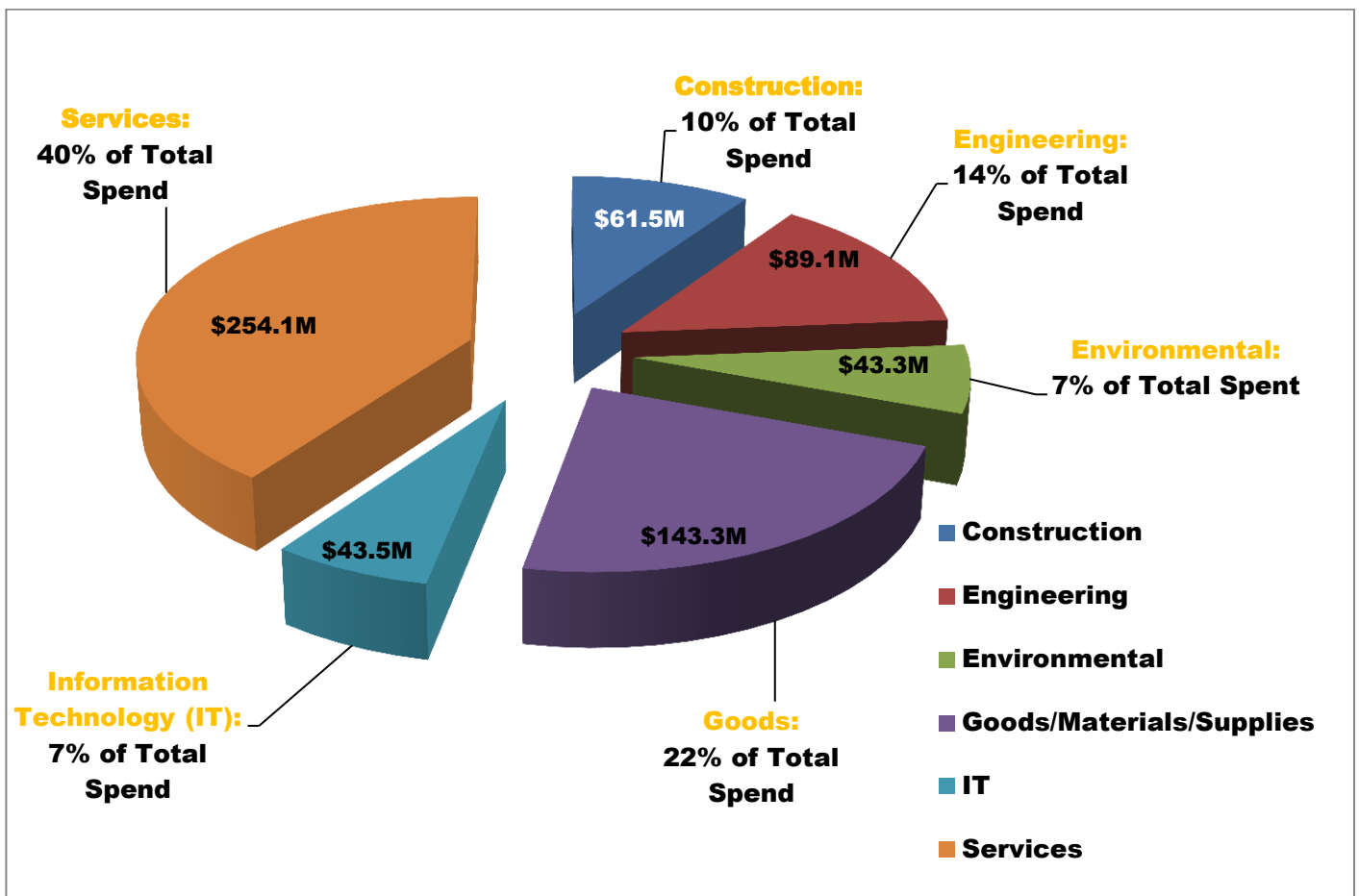




# Goods and services purchased by Los Alamos National Laboratory Fiscal Year 2012

The information below is a representation of the amount of dollars spent on goods and services needed to perform work at the Laboratory. This information can give students an idea of the impact that the Laboratory has on the local and national economies.

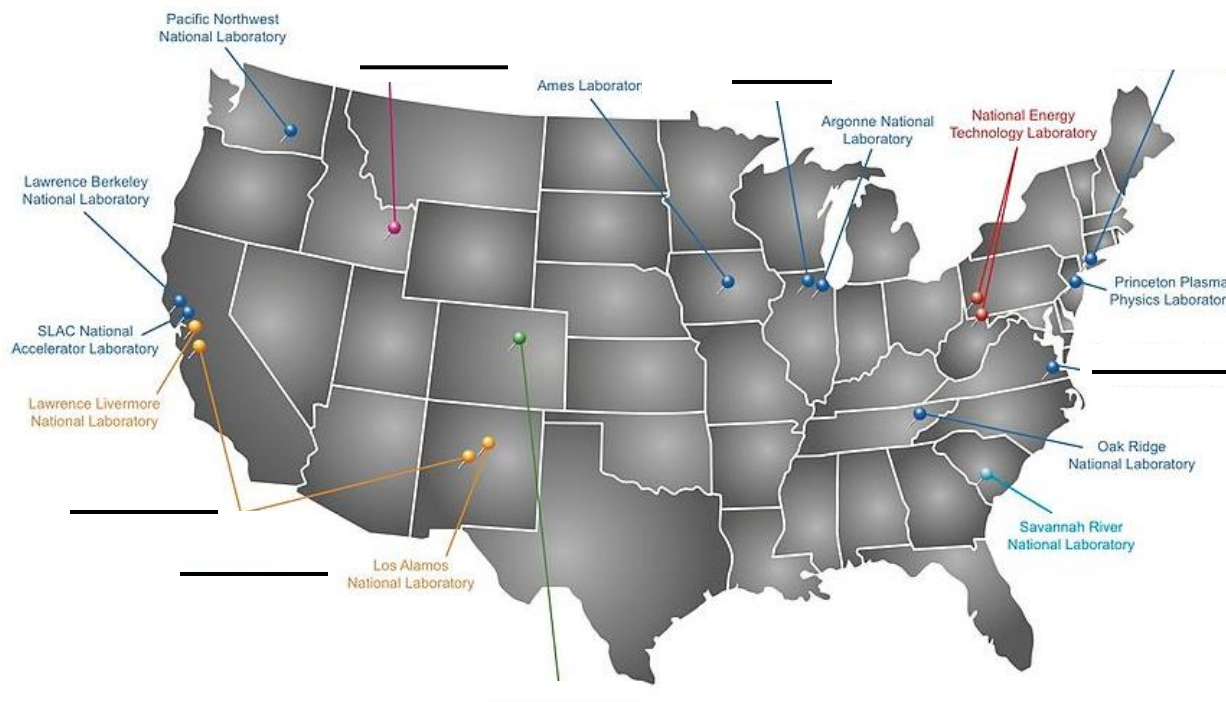
**Classroom activity:** You may want to have a classroom discussion about the different areas listed below. For example, you may ask students to identify what may be included in the costs for Information Technology (i.e., computers, copiers, etc.). You may also talk about how a major organization as the largest employer in the area impacts the local economy.









# National Laboratories

Los Alamos National Laboratory (the Laboratory) is one of 17 National Laboratories in the United States and is one of the two located in New Mexico. The Laboratory has a proud history of 70 years of science and innovation. The people at the Laboratory work on advanced technologies to provide the best scientific and engineering solutions to the nation's most crucial security challenges.

**Classroom Activity:** Each of the dots in the map below represents one of the 17 National Laboratories that is operated by the U.S. Department of Energy (DOE) whose mission is to ensure America's security by addressing its energy, environmental, and nuclear challenges. You may have your students do a little research on the internet to identify and label the six Laboratories whose names are missing below.



-  Office of Science laboratory
-  National Nuclear Security Administration laboratory
-  Office of Fossil Energy laboratory
-  Office of Energy Efficiency and Renewable Energy laboratory
-  Office of Nuclear Energy, Science and Technology laboratory
-  Office of Environmental Management laboratory

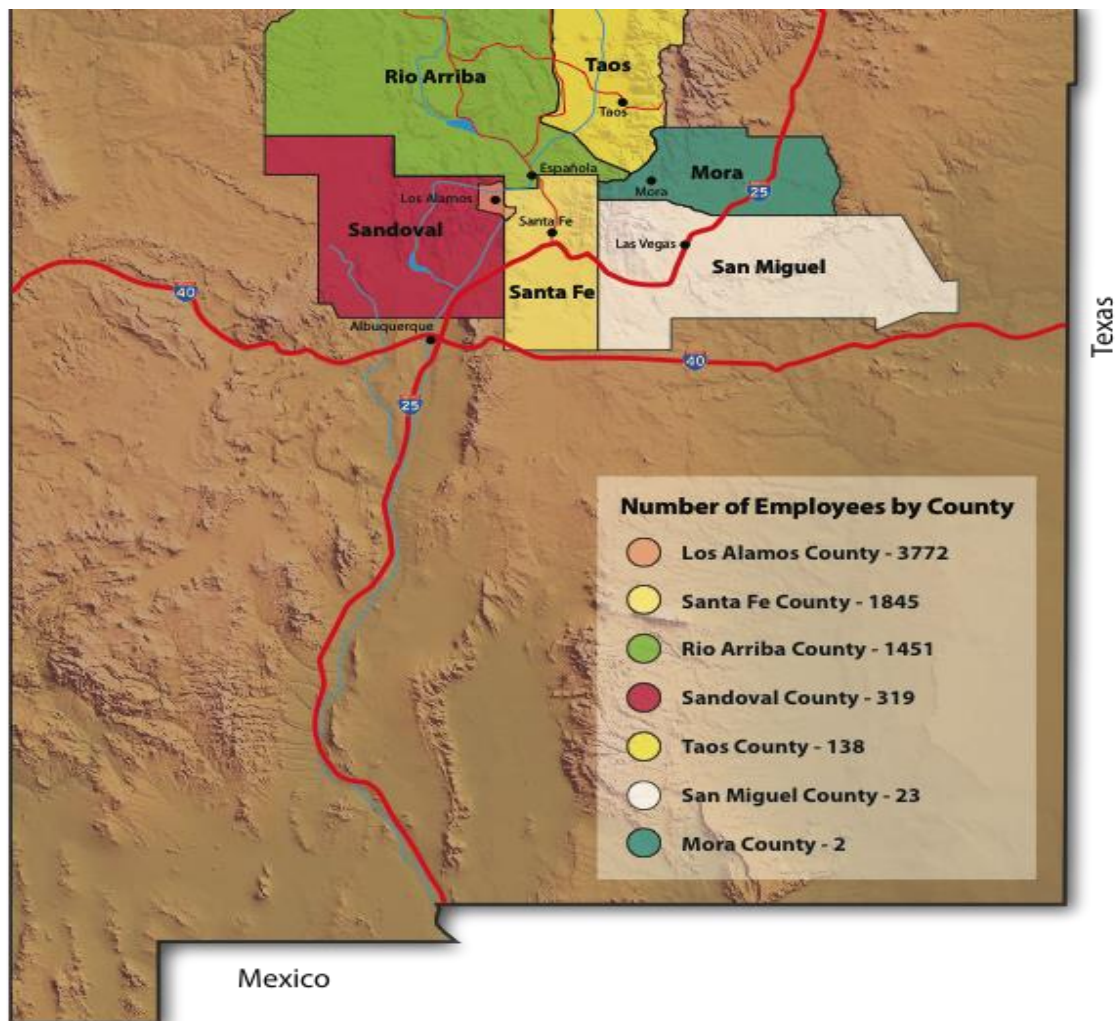


## Where do Laboratory employees live?

Los Alamos National Laboratory's employees live across Northern New Mexico, and many travel to Los Alamos for as long as two to three hours to get to work each day. Fortunately, in recent years the train and bus systems in the area have made it easier and less expensive for employees to travel these

distances.

**Classroom Activity:** You may have a classroom discussion about the importance of Los Alamos. Did you know that Los Alamos is the smallest county by area in the state? It is also one of the counties with the highest number of Doctors of Philosophy (Ph.D.) per capita than anywhere else in the country.





## What's so cool about Curiosity?

**Curiosity, the Mars Science Laboratory, is the largest and most complicated device we have ever landed on a planet other than Earth.**

- About the size of a small SUV -- ten feet long (not including the arm), nine feet wide and seven feet tall
- 900 kilograms (2,000 pounds) (Spirit and Opportunity, earlier research vehicles sent to Mars were 384 pounds)
- Uses aerobraking, parachute, retro rockets and sky crane concepts to land gently (Spirit and Opportunity used aerobraking, parachutes and airbags that bounced them to the surface)

**Curiosity carries three instruments from Los Alamos National Laboratory.**

- The Radioisotope Thermoelectric Generator supplies electricity and heat to the rover
- The ChemMin instrument uses X-Ray diffraction and fluorescence to analyze samples collected on the surface of Mars
- The ChemCam spectrographs analyze light emitted by rocks vaporized by a laser beam to identify their chemical composition

**Curiosity took over 8 ½ months to travel from Earth to Mars.**

- Earth and Mars are both moving at different speeds and only approach each other every two years
- Curiosity is designed to operate for a full Mars year, 687 Earth days
- In that time it can travel 5-20 kilometers (3-12 miles)

### **Cool Science Experiments!**

- Study geology of Mars
- Study climate on Mars
- Search for evidence of possible past life
- Help plan for human exploration of Mars



# DNA Extraction



Being able to extract deoxyribonucleic acid (DNA) is important for a number of reasons. By studying DNA, scientists can identify genetic disorders or diseases, and they can also possibly find cures for them by manipulating or experimenting with this DNA. At the Laboratory, researchers have studied DNA to detect biothreat agents in environmental and forensic samples. Scientists also are studying how human DNA may be destroyed by certain types of electromagnetic waves at certain frequencies.

**Classroom Activity:** This activity is about the extraction of DNA from strawberries. Strawberries are a great fruit to use for this lesson because each student can work on his or her own. Strawberries are recommended because they yield more DNA than any other fruit. Strawberries are octoploid, which means that they have eight copies of each type of chromosome. The objective for this lesson is for students to learn that DNA is in the food they eat and that each step is necessary because of the complex organization of DNA in cells. Students will also learn why it is important for scientists to extract DNA from organisms.

**Extraction Solution:** Mix the following in a sealable container and store in the refrigerator until you are ready to use it.

Ingredient	US Measure	Metric	Purpose
Water	1 $\frac{3}{4}$ cup	400 ml	Something to dissolve it all in
Dishwashing detergent	4 Tbs	50 ml	Breaks up cell membranes and some proteins
Salt	3 Tbs	44 ml	Neutralizes the negative charges of DNA and to allow the strands to come together
Meat tenderizer (like Adolph's)	2 tsp	10 ml	Contains papain which breaks up proteins that might degrade the DNA

## What you'll need to get started:

- Extraction solution (see above)
- Small plastic vial with lid
- 15 ml plastic tube





## DNA Extraction (cont'd)

- Large paper clip
- Small funnel
- Cheesecloth
- Sandwich-size plastic bag with zip top
- Fruit, one medium or large strawberry works best
- Rubbing alcohol (90% works best, put in refrigerator to get cold)
- Scissors

### What to do:

1. Put strawberry (stem removed) into the bag and zip shut
2. Place strawberry/bag into the refrigerator with the extraction solution and rubbing alcohol for at least two hours.
3. Carefully smash the strawberry in the bag, without breaking the bag. Be sure to get rid of all lumps.
4. Pour about  $\frac{1}{2}$  teaspoon (3mL) cold extraction solution into the bag.
5. Zip the bag again and mix the solution with the mush by laying the bag on a table and rubbing your fingers on it.
6. Line the funnel with a couple of layers of cheesecloth, letting it hang over the sides of the funnel.
7. Stand the tube upright (place in a heavy coffee cup), and put the funnel with cheesecloth in the tube.
8. Cut a piece off one corner of the bag and squeeze the strawberry extraction solution mush into the cheesecloth in the funnel. It helps to have one person hold the tube/funnel and a second person handle the bag.
9. Let the liquid drip into the tube. You can gather the top of the cheesecloth and gently squeeze it to help get the liquid out, but you do not want any solid material in your tube. You want about a teaspoon (5mL) liquid in the tube.
10. Tilt the tube to an angle very slowly drizzle about 1 tsp. (5mL) of cold rubbing alcohol down the side of the tube. The alcohol should float on top of the strawberry-extraction mixture.
11. Do not mix the liquids. You should see stringy strands of DNA at the interface of the two liquids because DNA is soluble in water but not in alcohol.
12. Insert the end of the unbent paper clip into the tube to the level of the DNA you see. Twirl and swirl the paper clip to twist the DNA into a glob.
13. Transfer the DNA into the small vial, add a little alcohol, and seal the vial. The DNA will be a stringy, mucous-like material; some of the fruit cellulose may be attached to the DNA and will look like wet cotton. DNA is colorless, so any color you see is the result of the color from the fruit precipitating with the cellulose.



## Questions about Magnets

The Laboratory does a lot of work with magnets, in fact, some of our scientists work in a facility that has broken world records in producing magnetic fields (the area around a magnet in which there is magnetic force). The facility is called the National High Magnetic Field Laboratory.

You are welcome to share a tour of the facility by visiting the virtual tour at the following website: <http://www.lanl.gov/orgs/mpa/nhmfl/users/tour/welcome.html>. Below are some activities that you may want to try with your students or have them try at home with their parents.

### What happens when we break a magnet in half?

You can purchase some cheap ceramic magnets in several shapes. Get a ring-shaped magnet and break it with pliers or a tap with a hammer. Try to put it back together. What happens? Why? Try to find a bar magnet that is magnetized end-to-end and break that. What is the difference? Can you break off just the north (or just the south) end of a magnet?

### Are magnets stronger than gravity?

Hold a magnet in the air. Place a nail against it. The magnet holds the nail up against gravity, proving that magnetism is stronger than gravity, right? Now take off the nail and lay it in your hand or on a surface several inches below the magnet. Now which is stronger, gravity or magnetism? What is going on?

### How do flexible refrigerator magnets work?

Get two of these flexible magnets, often the size of a business card. If you only have one, then cut it in half with scissors. Put the pieces together printed side to printed side. How sticky are they? Turn one over and try that. Put them together black to black and pull them apart. Turn one 90 degrees. Does it make a difference? With black to black, slide one across the surface of the other. Try it with the pieces turned at different angles to each other. Try sliding them in different directions. What do you feel? Draw a diagram describing what you have figured out.

### Make a chaotic magnet pendulum!

Hang a magnet on a string from the ceiling or a light fixture (be careful) over a table. Tape other magnets around the area below where the magnet hangs. Swing the magnet and watch its motion. If you want to get fancy, use hot glue to attach a ring magnet to a foot-long dowel so it hangs facing the table, and attach the string to the other end.



# Fast Facts about Los Alamos National Laboratory

## People

- Total employees, 10,312
- Los Alamos National Security, LLC 6,886
- SOC Los Alamos (Guard Force), 381
- Staff/Support contractors, 774
- Students, 799
- Unionized craft workers, 709
- Post doctoral researchers, 411
- Others, 472

## Place

- Located 35 miles northwest of Santa Fe, New Mexico, on 36 square miles of DOE-owned property
- More than 2,000 individual facilities, including 47 technical areas with 8 million square feet under roof.

## Budget

- FY 2013: Approximately \$2,.1 billion
  - 54% Weapons program
  - 10% Nonproliferation programs
  - 5% Safeguards and Security
  - 9% Environmental Management
  - 5% DOE Office of Science
  - 3% Energy and other programs
  - 14% Work for Others



*updated May, 2013*

